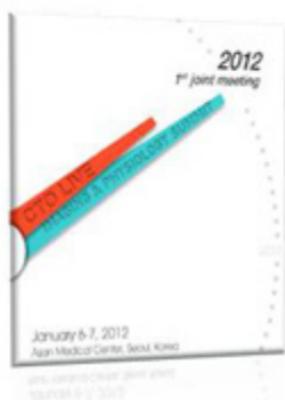


~ Case Presentation & 5-Slides Focus Review~

Mechanism of In-Stent Restenosis

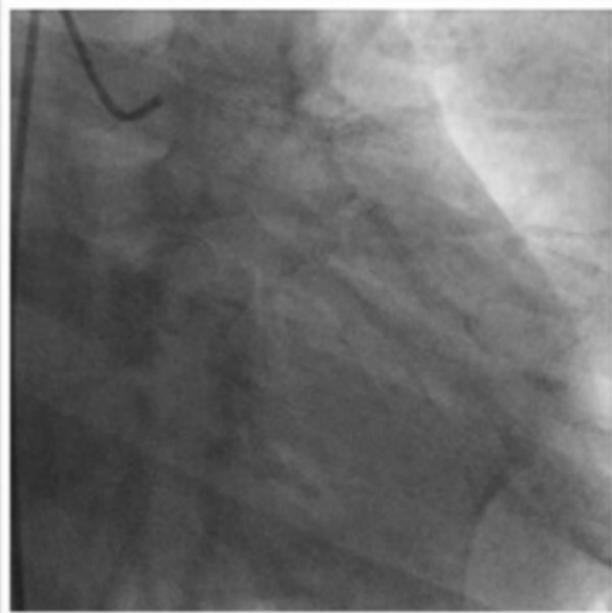


Seung-Ho Hur, MD, PhD, FACC

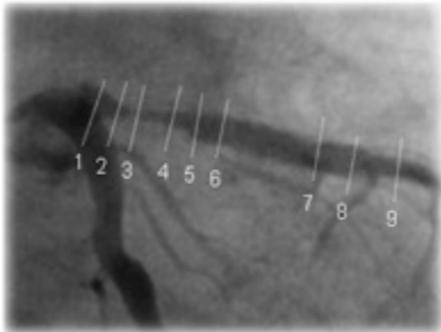
Keimyung University Dongsan Medical Center

Case I

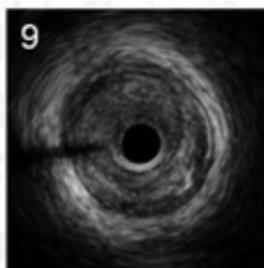
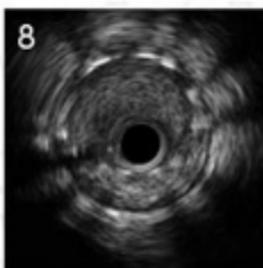
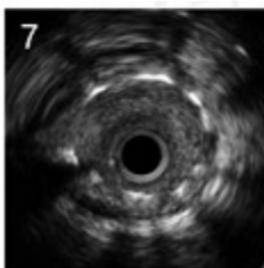
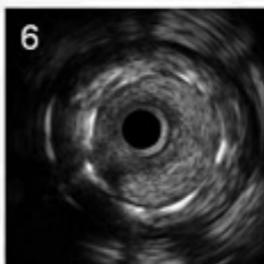
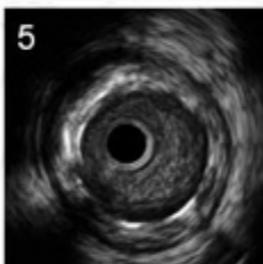
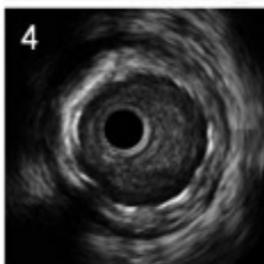
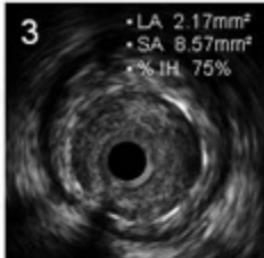
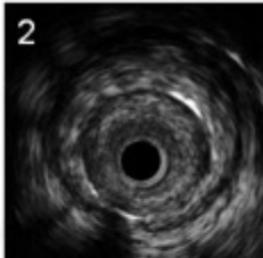
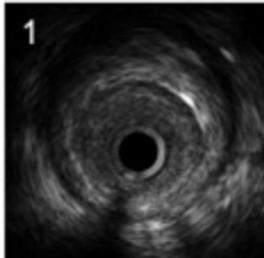
- 61YO / Male
- Unstable Angina
- T2DM, Smoking (+)
- 2Y ago: SES (3.5x28mm) dt NSTEMI
- DES ISR Type IC



Pre-PCI IVUS Findings

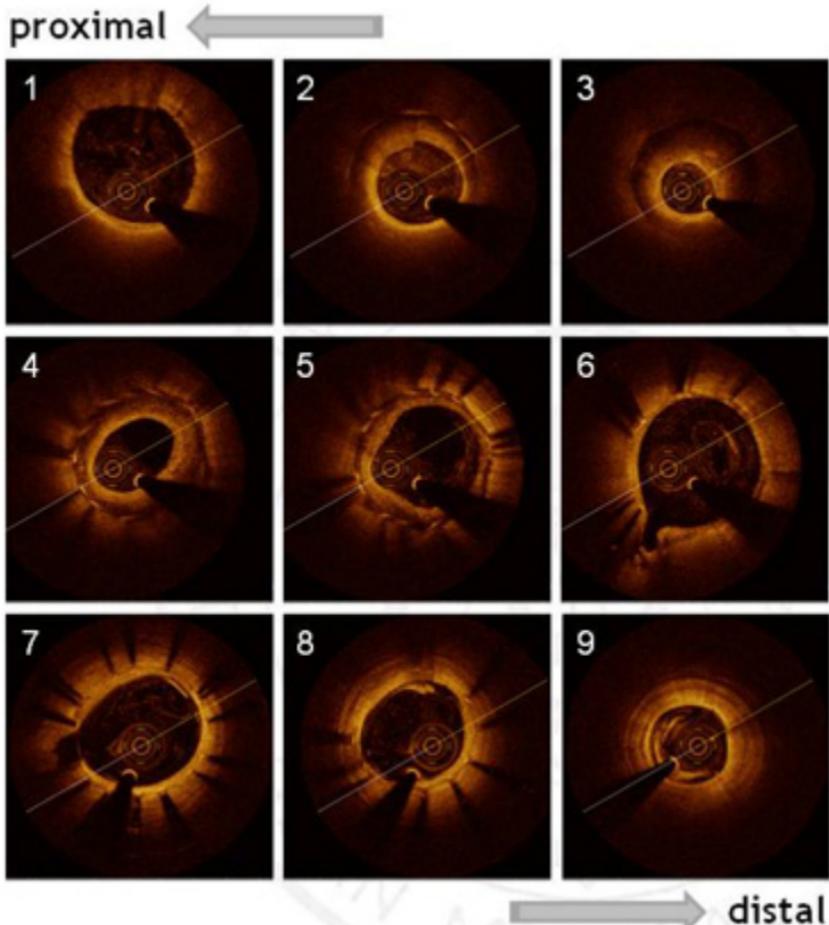
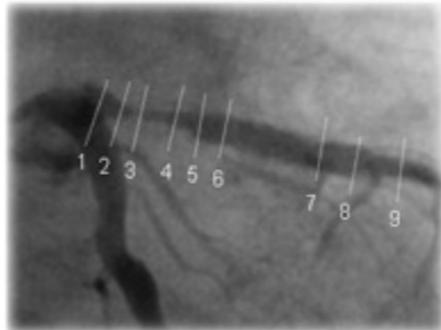


proximal ←



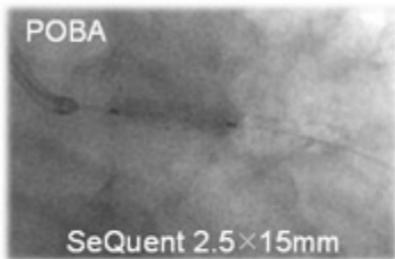
distal →

Pre-PCI OCT Findings



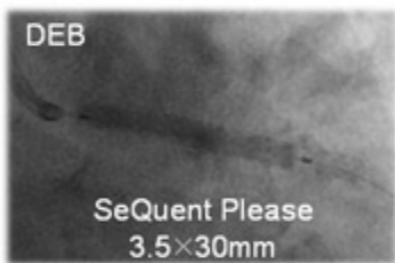
PCI for DES ISR

POBA

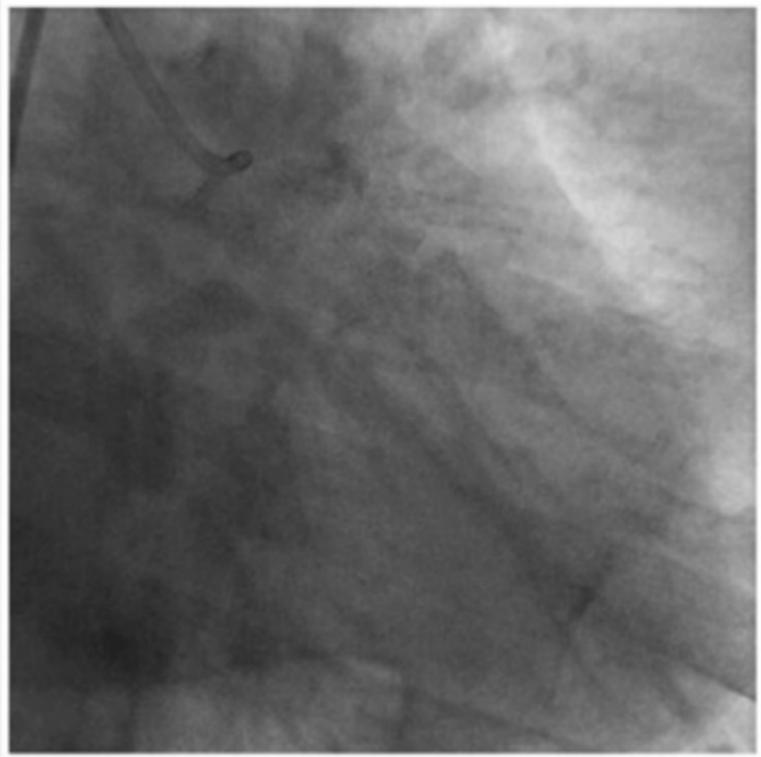


SeQuent 2.5×15mm

DEB



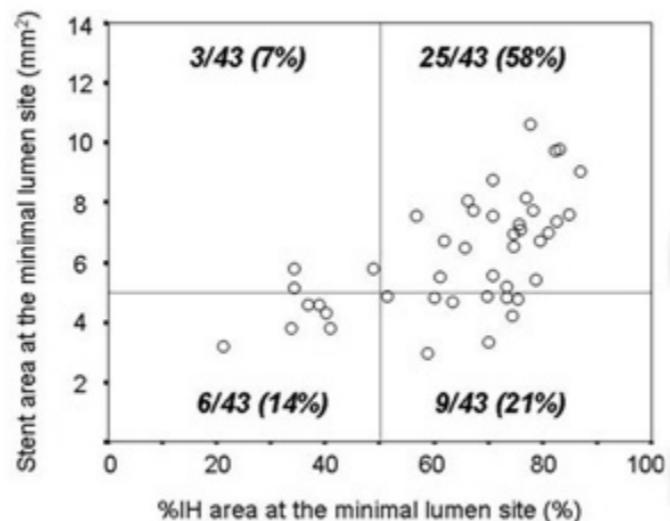
SeQuent Please
3.5×30mm



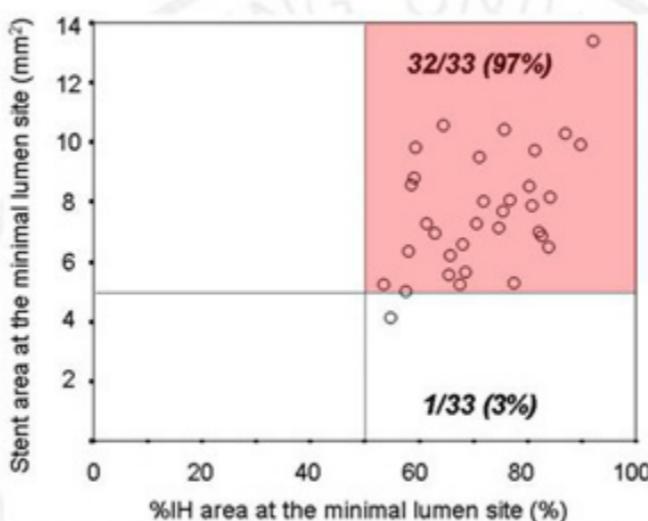
Final CAG

Mechanisms of ISR after DES Implantation

47 lesions with total stent length >28 mm



33 lesions with total stent length ≤28 mm



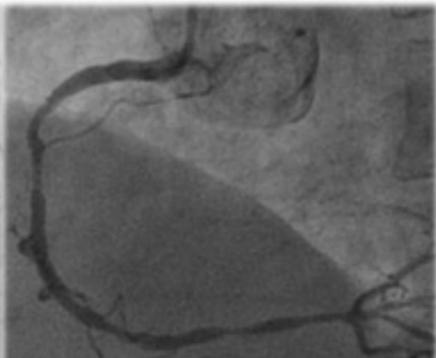
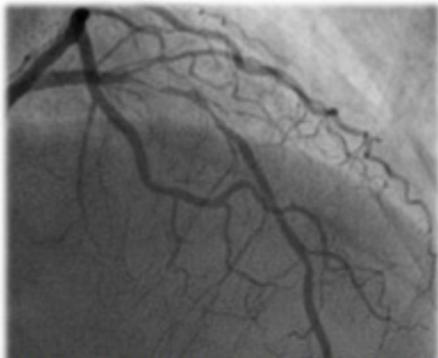
- In most DES restenosis, **intimal hyperplasia** was the dominant mechanism of ISR.
- Nevertheless, underexpansion associated with longer stent length remained an important preventable mechanism of ISR.

Case II

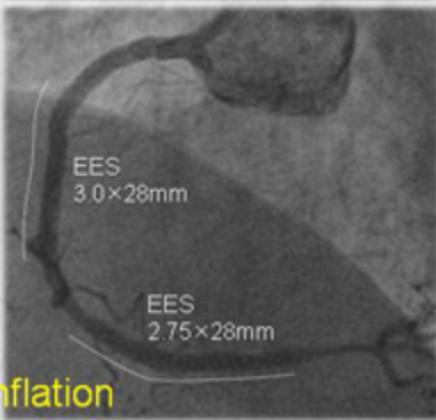
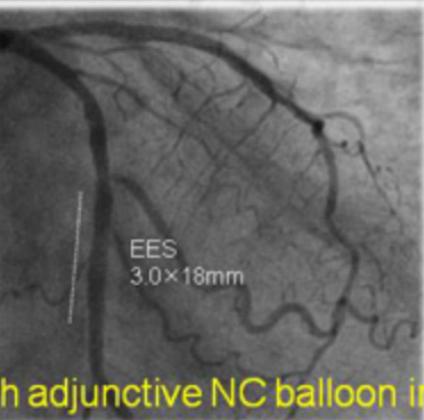
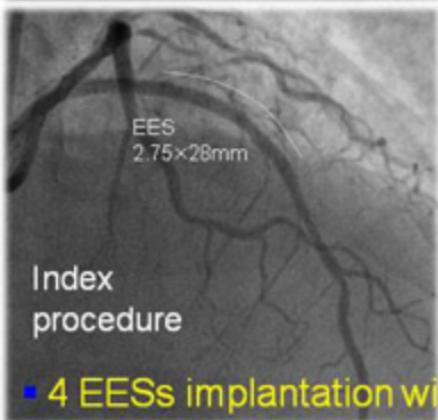
- 71YO / Female

- NSTEMI

- T2DM, HTN



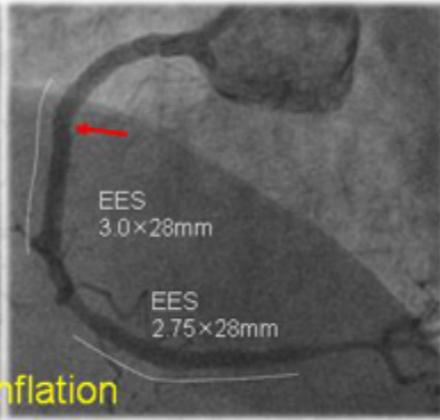
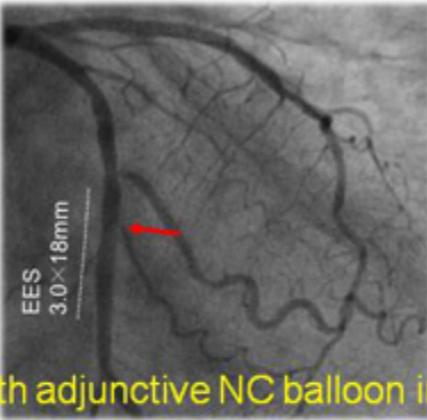
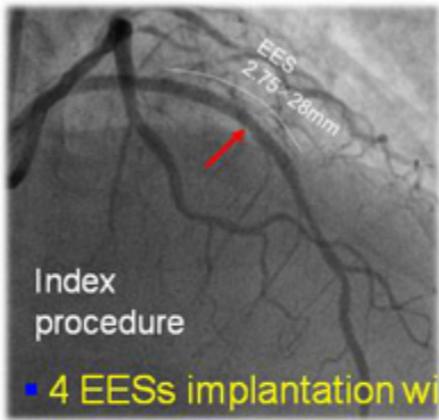
- 8 Mo ago: Stable Angina \Rightarrow CAG: 3VD



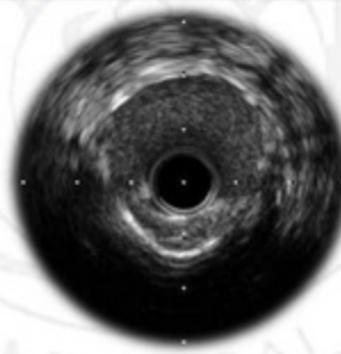
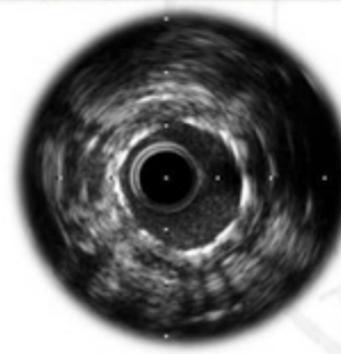
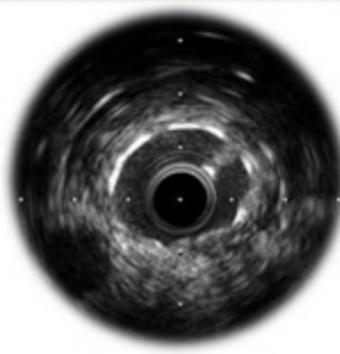
- 4 EESs implantation with adjunctive NC balloon inflation

MSA after Stenting in Each Vessel

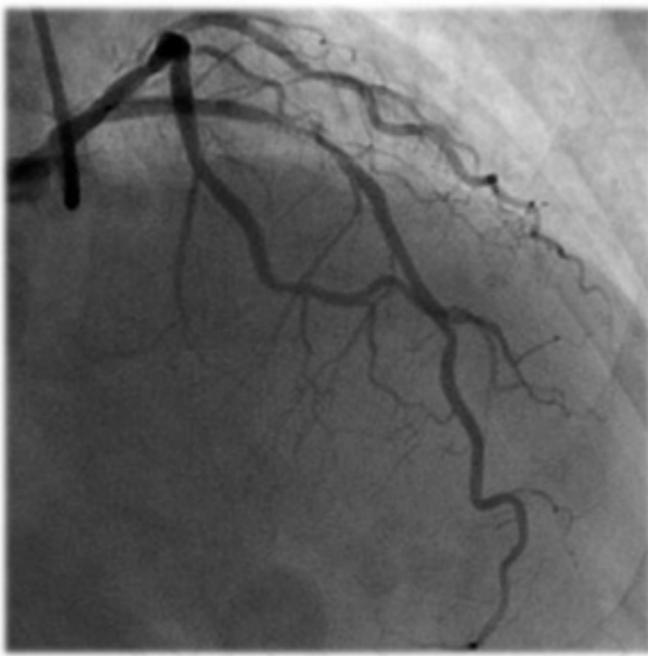
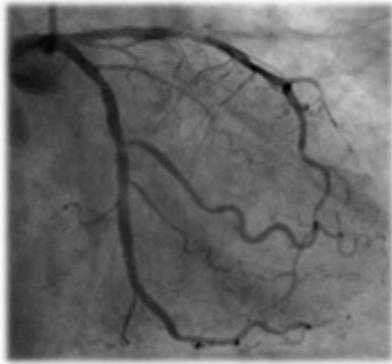
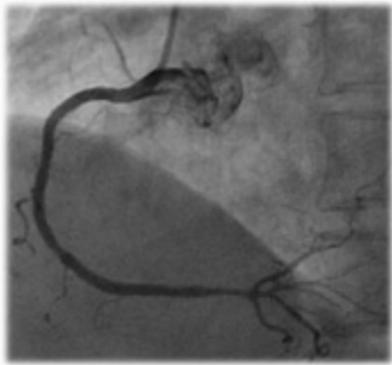
~ 8 Months ago ~



- 4 EESs implantation with adjunctive NC balloon inflation

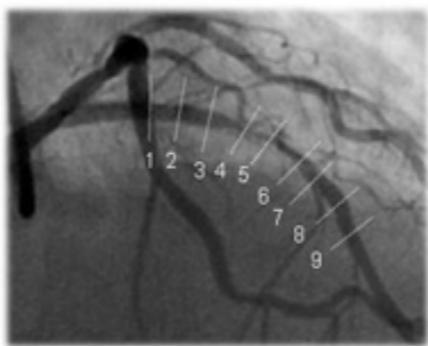


ACS Presentation @ 8M FU

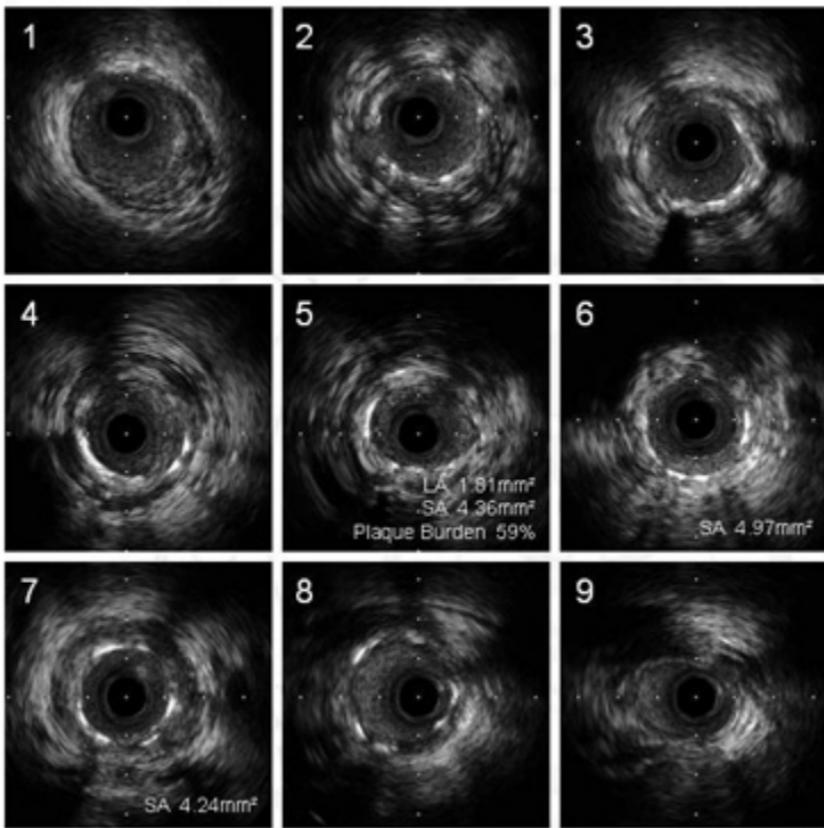


- DES ISR Type II

IVUS Pullback

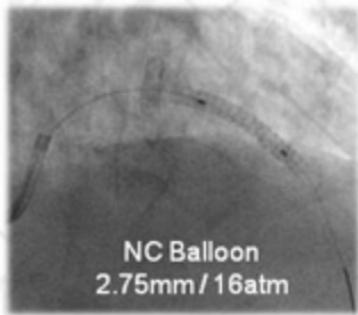
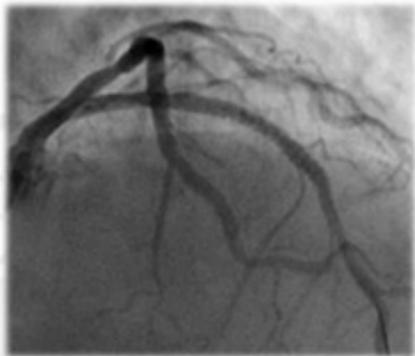
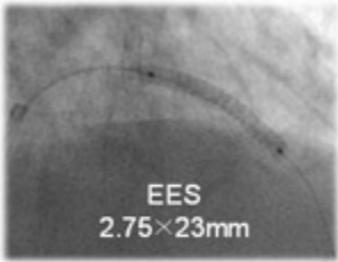
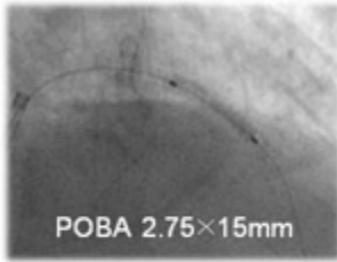


proximal ←



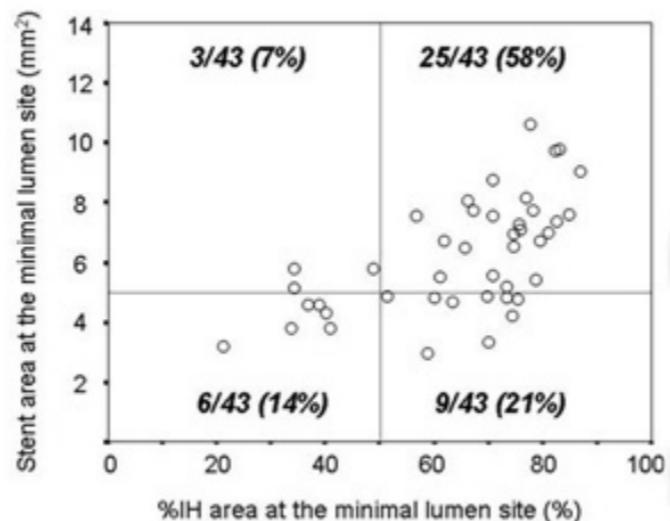
→ distal

PCI for DES ISR

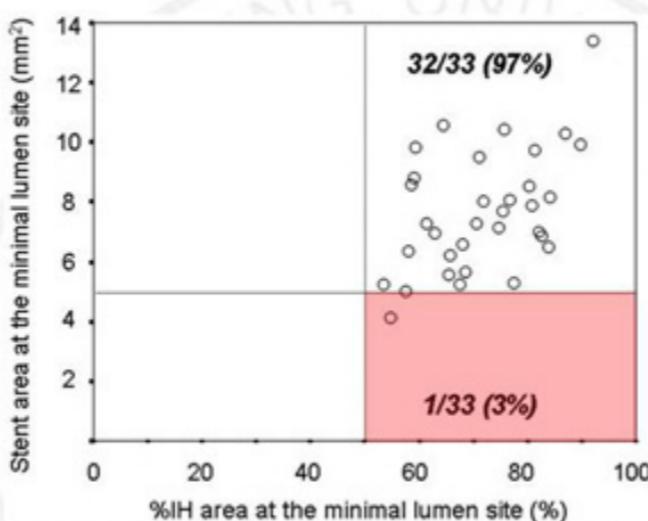


Mechanisms of ISR after DES Implantation

47 lesions with total stent length >28 mm



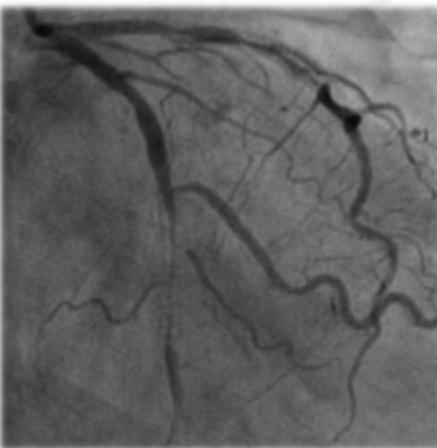
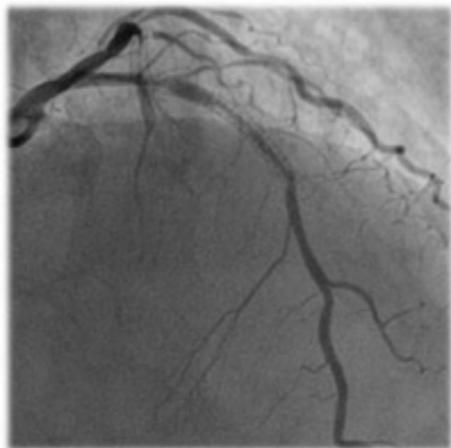
33 lesions with total stent length ≤28 mm



- In most DES restenosis, **intimal hyperplasia** was the dominant mechanism of ISR.
- Nevertheless, underexpansion associated with longer stent length remained an important preventable mechanism of ISR.

2nd ACS Presentation @ 6M FU

~ 14M after index procedure ~



▪ DES ISR Type II

▪ DES ISR Type III

▪ DES ISR Type II

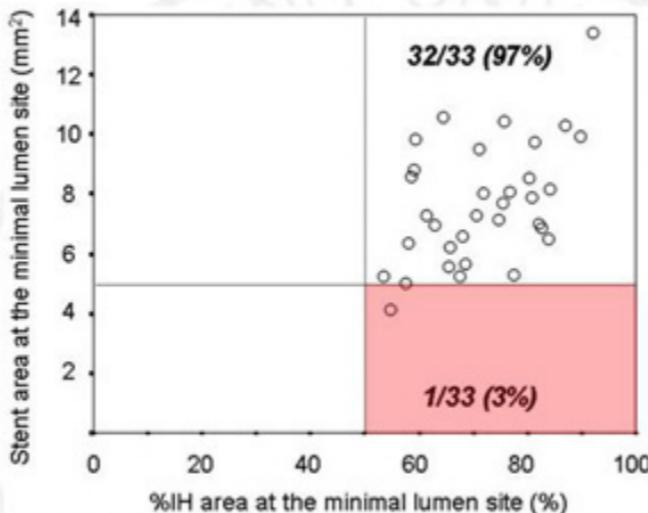
Mechanisms of ISR after DES Implantation

- Technical factor
 - stent underexpansion



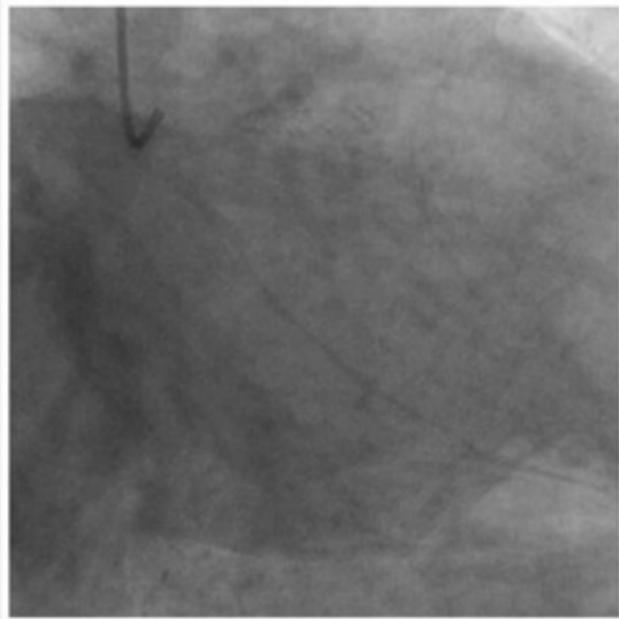
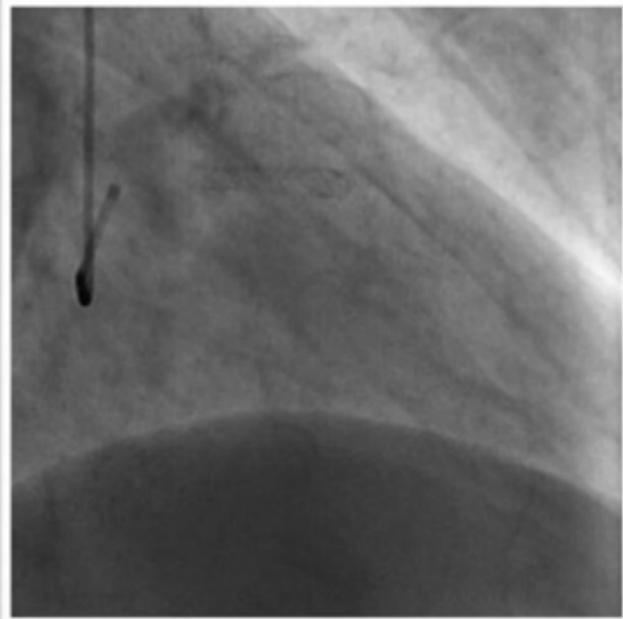
- Biologic factors
 - Intimal hyperplasia
 - hypersensitivity
 - drug resistance

33 lesions with total stent length ≤ 28 mm

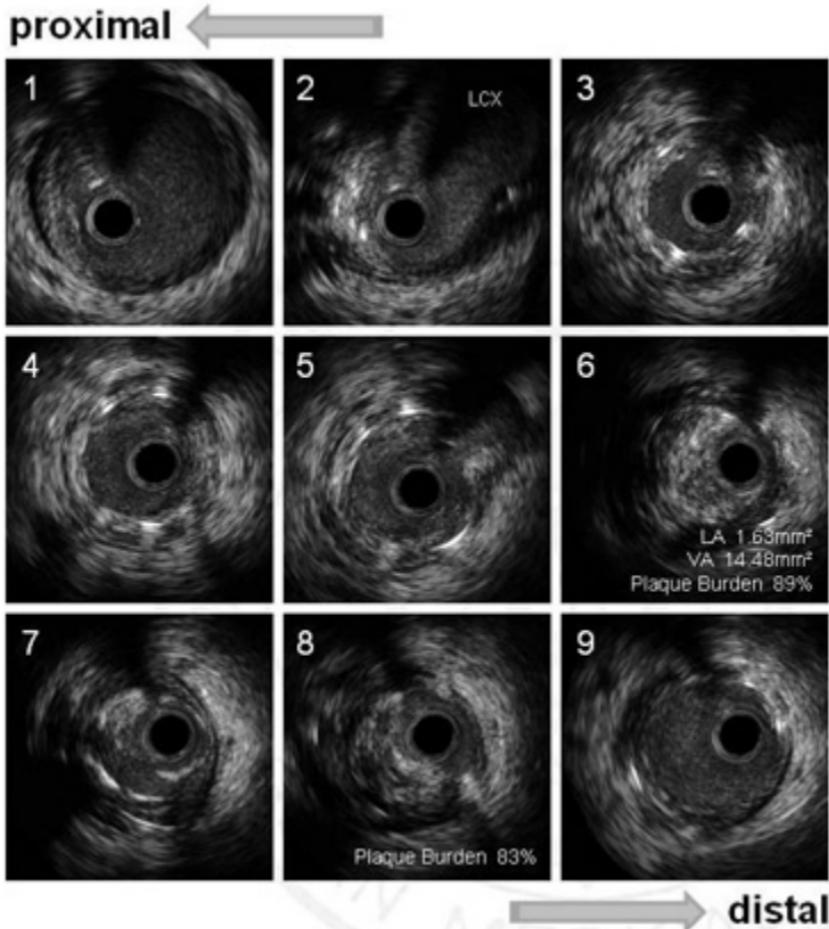
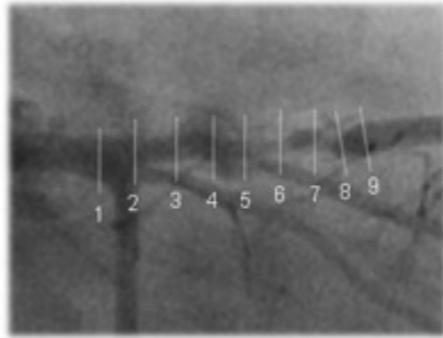


Case III

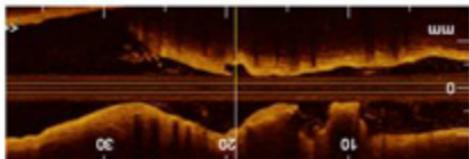
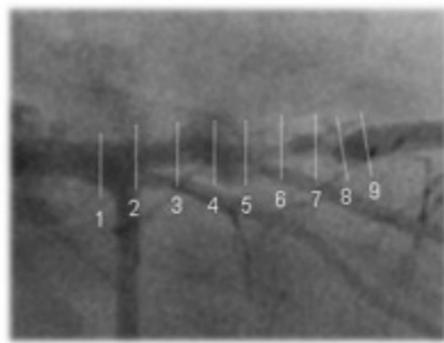
- 68YO / Male
- Unstable Angina
- Smoking (+)
- 15Y ago: BMS (4.0x25mm) dt UA
- BMS ISR Type III



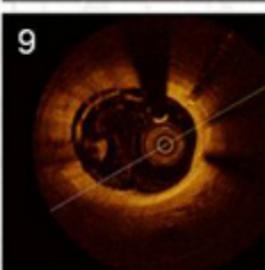
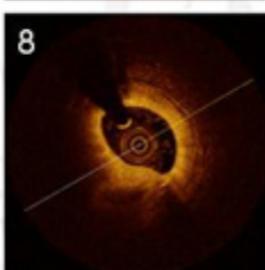
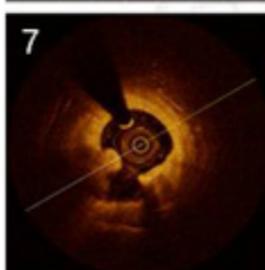
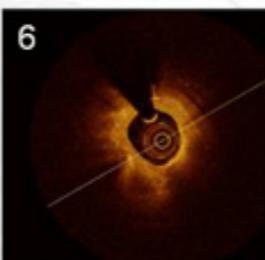
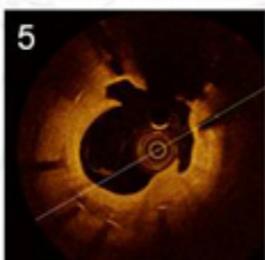
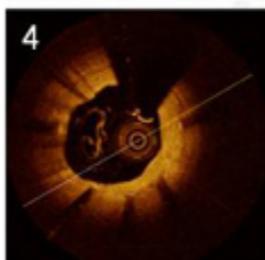
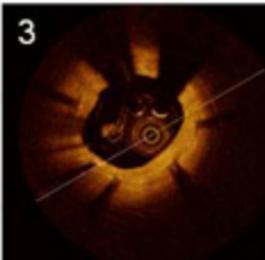
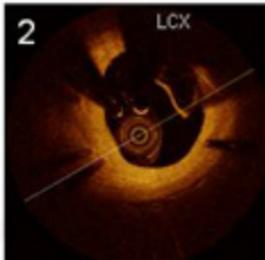
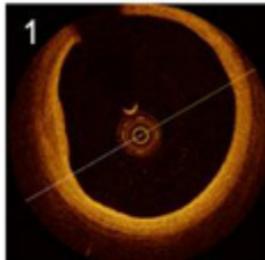
Pre-PCI IVUS Findings



Pre-PCI OCT Findings

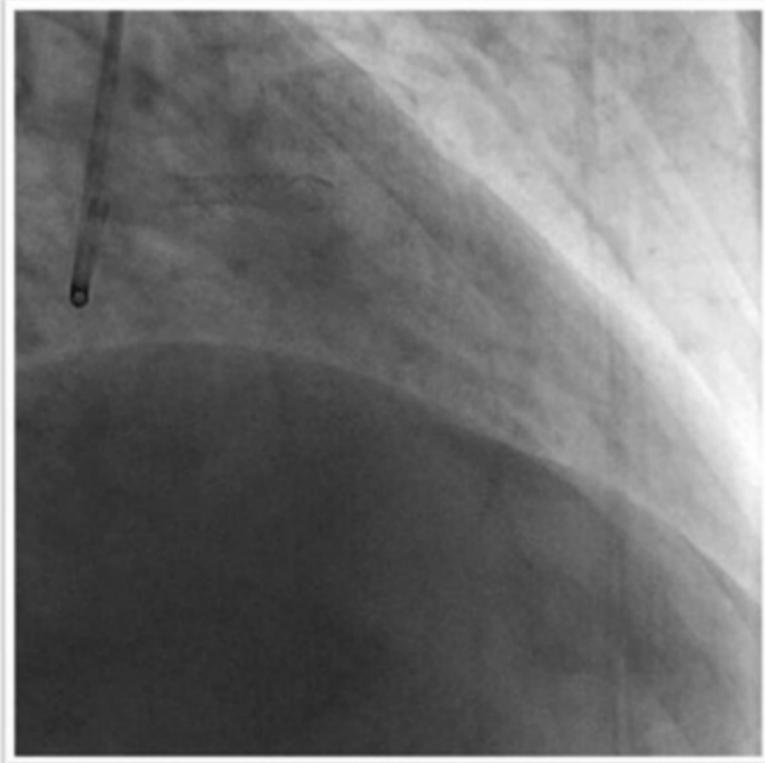
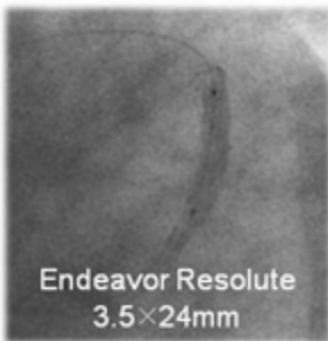
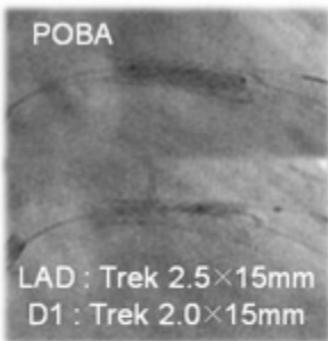


proximal ←



distal →

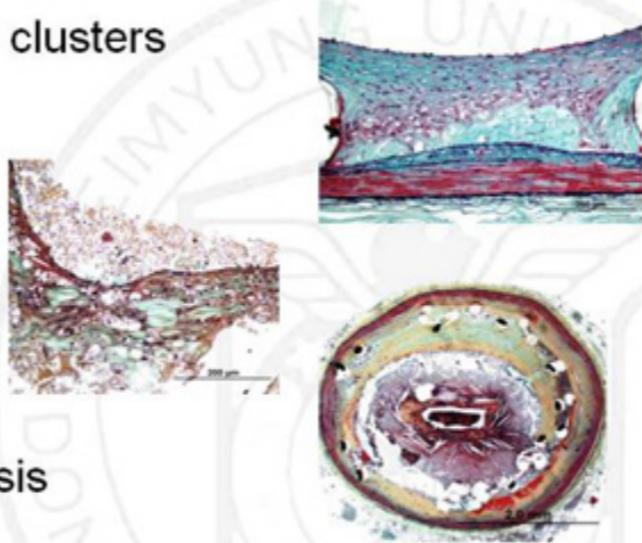
PCI for DES ISR



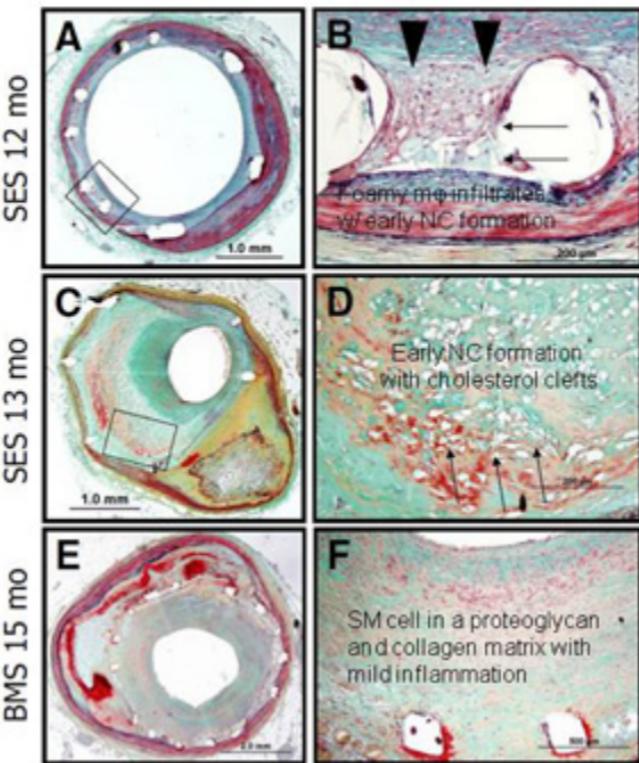
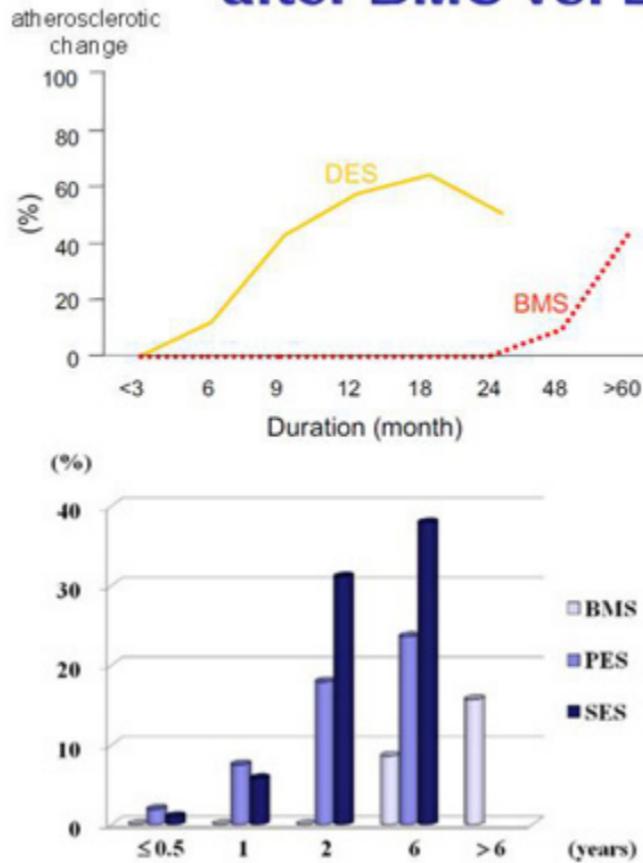
Final CAG

Histologic Features of Neoatherosclerosis within the Stent

- Peri-stent foamy macrophage clusters with or without calcification
- Fibroatheromas
- Thin-cap fibroatheromas
- Plaque ruptures with thrombosis
- No communication of the lesion within the stent with the underlying native atherosclerotic plaque



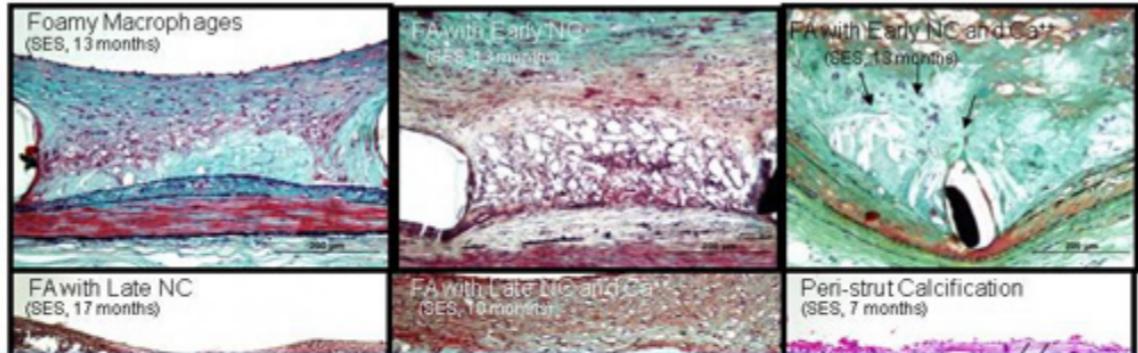
Different Timing of Neoatherosclerosis after BMS vs. DES Implantation



Nakazawa G et al, JACC Img 2009;5:625-628
 Nakazawa G et al, JACC 2011;57:1314-1322

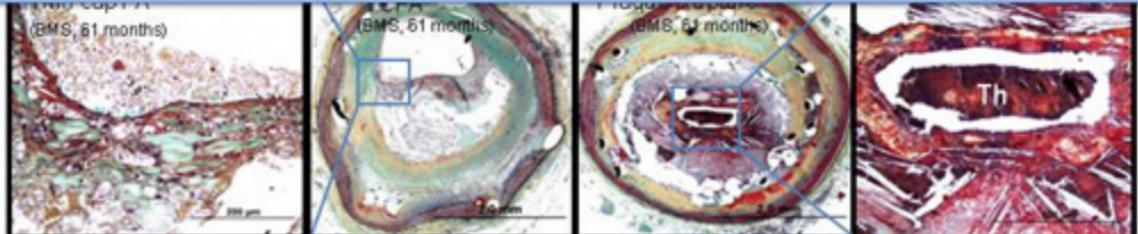
Pathology of Neoatherosclerosis between DES and BMS

DES

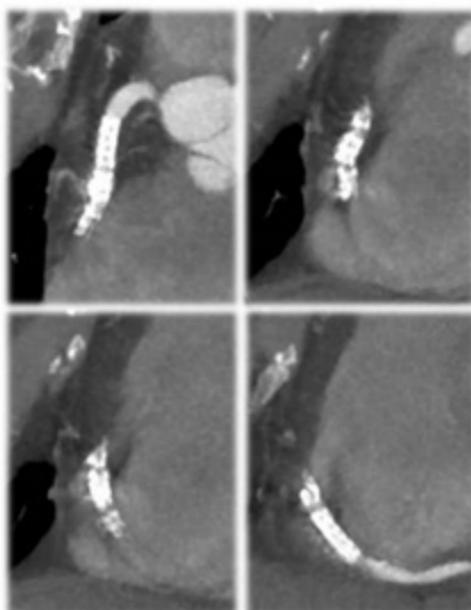


Histopathologic features of neoatherosclerosis are not significantly different between DES and BMS

BMS

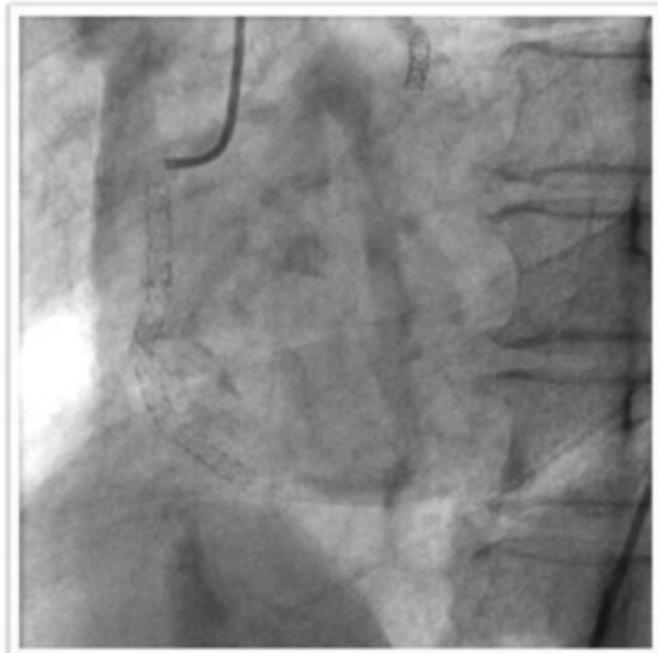
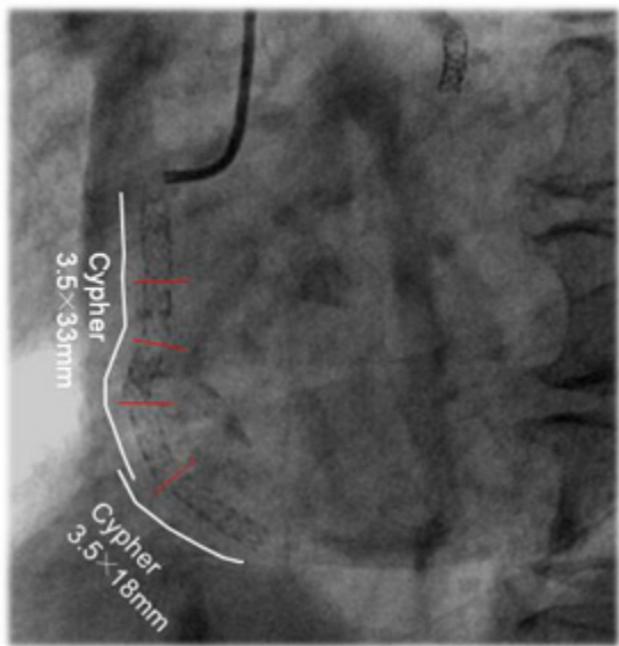


Case IV

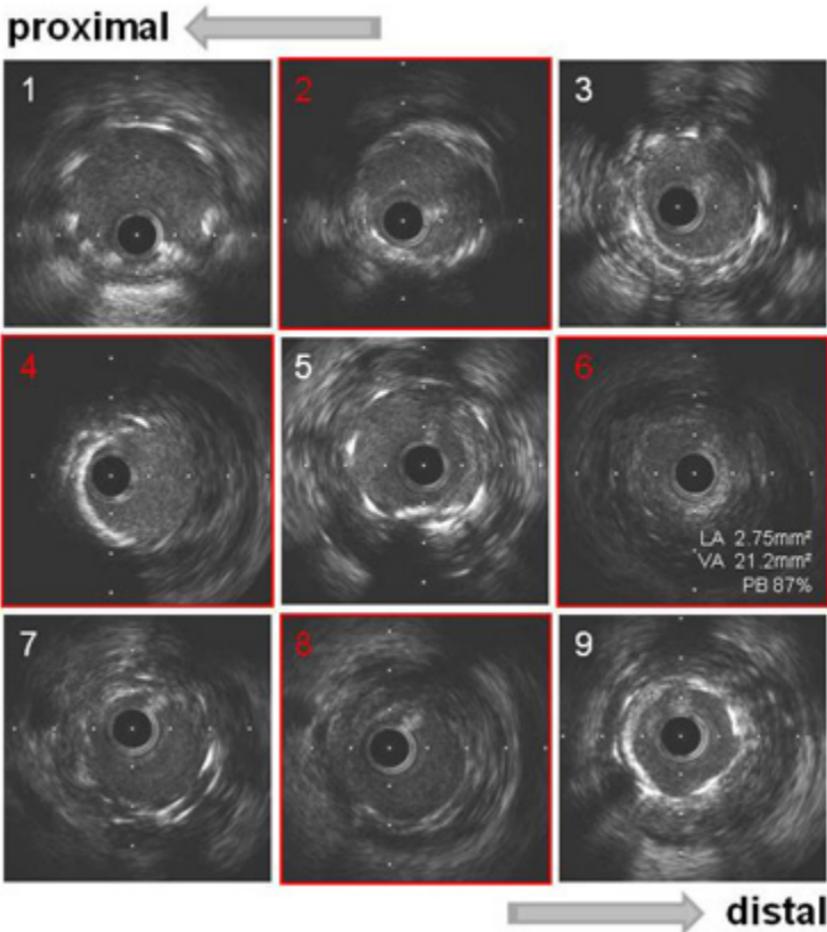
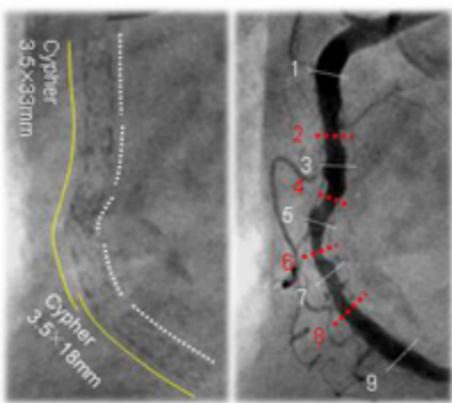
- 69YO / Female
 - Unstable Angina
 - Smoking (+)
 - 6Y ago
 - delayed PCI for STEMI (ant.)
 - * LAD m: focal disease
 - SES (3.0x18mm)
 - * RCA p-m: diffuse disease
 - 2 SES (3.5x33, 3.0x18mm)
with overlapping
 - TTE: severe hypokinesia
of LAD territory. EF 42%
- CT Angiogram
- 
- The image consists of four grayscale axial slices from a CT angiogram of the coronary arteries. The top row shows two slices: the left one displays a significant narrowing in the proximal segment of the left anterior descending (LAD) artery, which is labeled as having focal disease and treated with a single stent (SES). The right slice in the top row shows a more extensive, diffuse narrowing in the proximal right coronary artery (RCA), which required two stents (SES). The bottom row shows two more slices: the left one shows a similar focal narrowing in the LAD, and the right one shows the distal RCA after the placement of the two stents. The coronary vessels are visualized against a dark background, with the stents appearing as bright, curved structures.

ACS Presentation @ 6Y FU

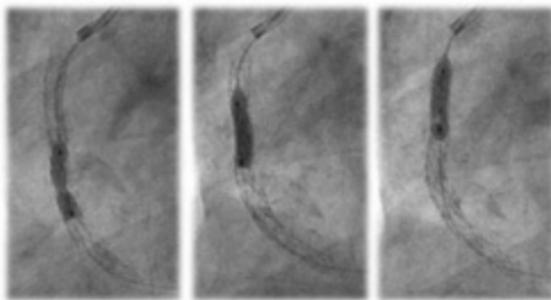
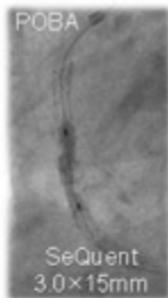
- Multiple stent fractures with DES ISR Type II



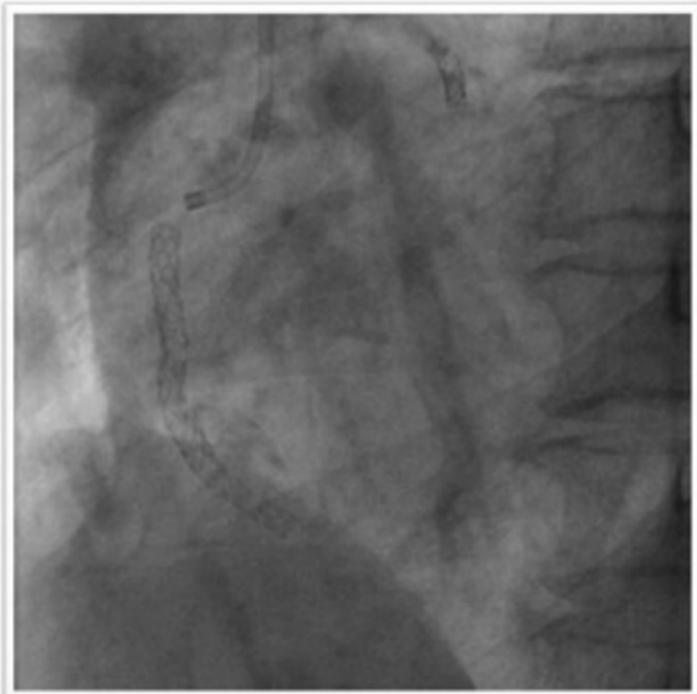
IVUS Findings



PCI for DES Fractures w/ ISR



NC balloon (3.5mm) inflation



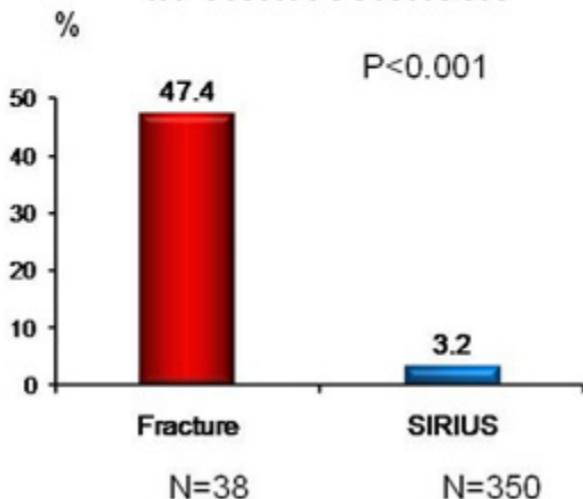
Final CAG

Stent Fracture Analysis

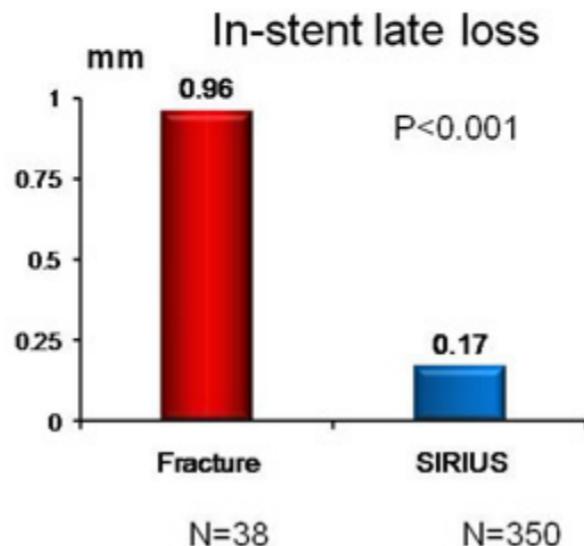
Review of Adverse Event Reports
submitted to Cordis between August 2003 - July 2006

Follow-up findings

In-stent restenosis

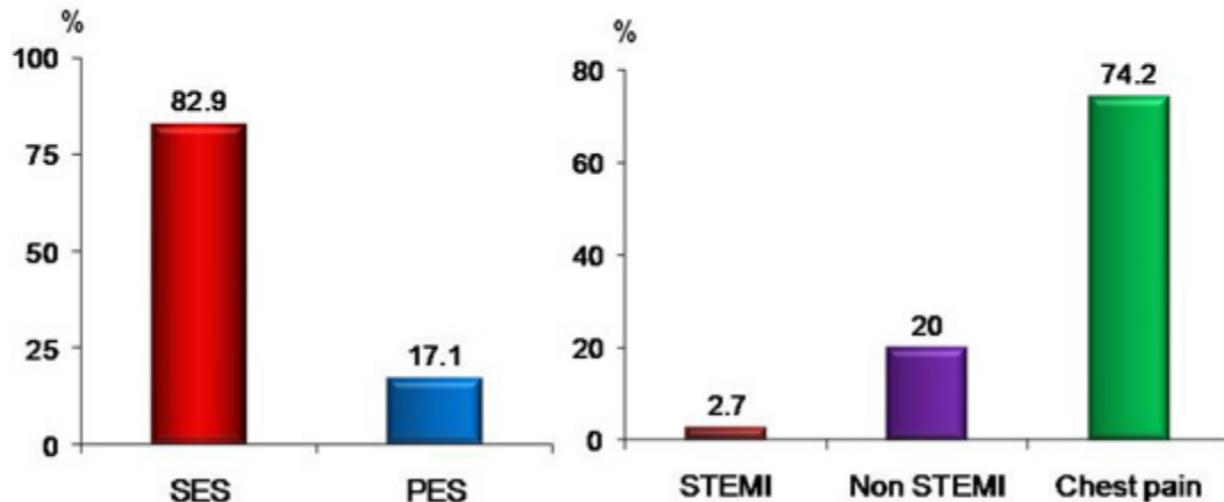


In-stent late loss



Incidence and Clinical Presentation of Stent Fractures

Among 188 pts with DES restenosis, stent fracture was identified in 35 (**18.5%**) cases



SUMMARY

~ Mechanisms of ISR ~

Biological Factors

- intimal hyperplasia
- hypersensitivity
- drug resistance (DES)
- neoatherosclerosis

Mechanical Factors

- stent fractures
- non-uniform stent struts distribution
- polymer peeling (DES)
- non-uniform drug deposition (DES)

Technical Factors

- stent underexpansion
- stent gaps or 'misses'
- barotrauma to unstented segments